Sept. 30, 1958 O. R. NEMETH 2,854,545

MINIATURE SWITCHING APPARATUS

Filed Feb. 4, 1957 2 Sheets-Sheet 1

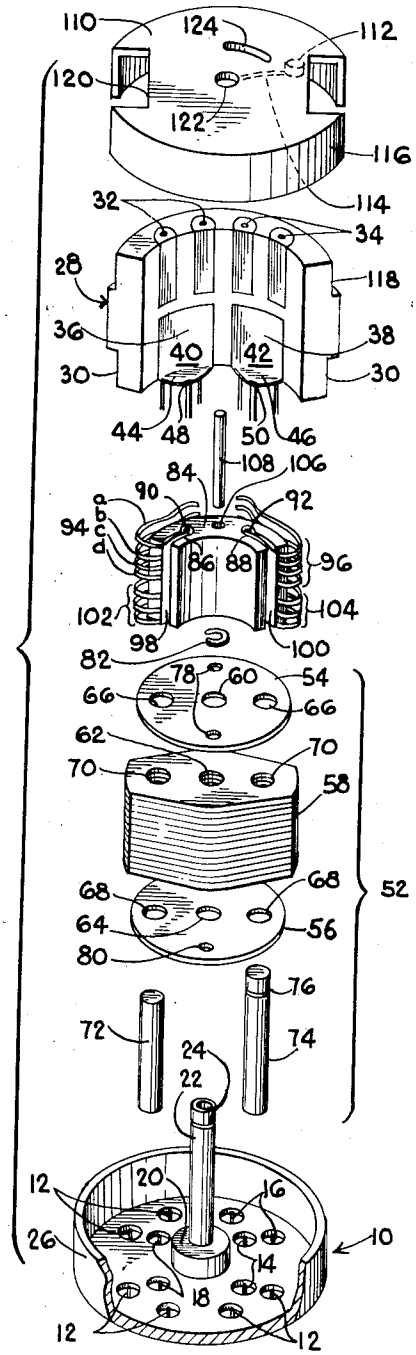


FIG. 1

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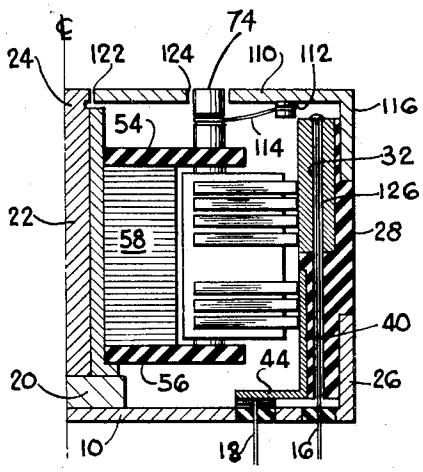


FIG. 2

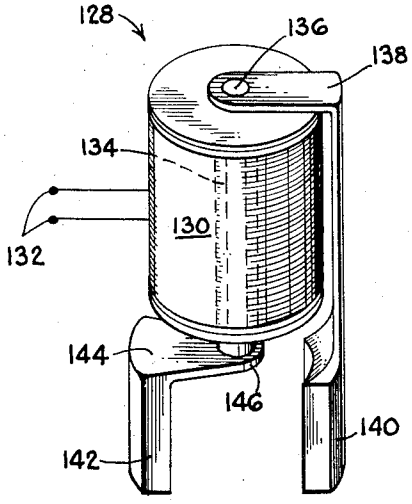


FIG. 3

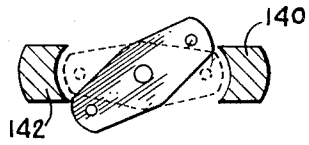


FIG. 4

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MINIATURE SWITCHING APPARATUS

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3 Claims. (Cl. 200—87)

The invention generally relates to miniature switching apparatus and more particularly to a relay device particularly adaptable for aircraft and guided missile applications.

Although the invention will be described primarily from the viewpoint of the aircraft and guided missile industry, it will be appreciated that certain of the advantages and features of this improved switching apparatus or relay device are adaptable to other structures which have similar requirements.

It is well known in aircraft and guided missile construction that unusual service requirements are oftentimes necessary in the various components employed. In addition to the weight and temperature considerations, it is important that components be properly balanced and constructed to resist unpredictable vibrations and excessive acceleration to which the overall installation may be subjected.

It is, therefore, an object of the present invention to provide a miniature switching apparatus or relay device which includes a balanced electromagnetic actuating mechanism having its highest torque upon application of current.

Another object of the present invention is to provide a miniature switching apparatus or relay device which is inherently balanced to provide a maximum resistance to acceleration forces and vibrations.

Another object of the present invention is to provide a miniature switching apparatus or relay device in which the contact arrangement is such that low contact pressures are possible and yet self cleaning of the contacts is achieved in a manner such that contact sticking and burning is essentially eliminated.

A still further object of the present invention is to provide a miniature switching apparatus or relay device which fulfills the aforegoing objects, and yet which is susceptible of light weight, rugged construction, with minimum overall dimensions.

These and other objects and advantages of the present invention are generally achieved by providing an improved relay comprising an armature rotatably supported on bearing means, preferably in the form of an elongated shaft or rod. In addition, means in the form of a spring or the like are fixed on the unit with respect to the armature and are adapted to bias the armature towards a first position, which may be the normal position of the unit.

Electromagnetic means are further provided and positioned so as to actuate the armature to a second given position when energized.

Stationary contact means are included in the relay in spaced relationship from the armature, and moving contact means are coupled for movement with the armature and adapted to make and break contact with the stationary contact means, respectively, when the armature is actuated to its second given position and returned to its first position.

In a preferable embodiment the armature is co-axial with the bearing means such that its first and second given positions may be established by a given angular

rotation. It is further desirable that the armature normally be disposed in such a position that the highest torque will act on the armature at the time of application of current to the electromagnetic means. With such a construction, the electromagnetic means will first move, then dampen, and then finally stop the armature at the time it is aligned with the pole pieces of the electromagnetic means.

A better understanding of the present invention will be had by reference to the drawings, illustrating a preferred embodiment, in which:

Figure 1 is an exploded isometric view of the improved relay device;

Figure 2 is a sectional view of the assembled unit of Figure 1;

Figure 3 is an isometric view of one form of electromagnetic means which might be employed with the relay device of Figure 1 to provide actuation of the armature; and

Figure 4 is a schematic representation of the armature positions with respect to the pole pieces of the electromagnetic means of Figure 3.

Referring now to the drawings, there is shown in Figure 1 one form of construction of the miniature switching apparatus or relay device including a bottom casing or cap **10** having a plurality of outer terminal apertures **12** and inner terminal apertures **14** adapted for passage of leads **16** and **18**, respectively, therethrough. It will be noted that in the cap **10** shown in Figure 1, eight apertures **12** are shown and four apertures **14** are shown. The particular arrangement and number of apertures will depend on the design requirements of the relay; in this illustrative embodiment the unit is designed for four pole, double throw operation.

Centrally secured to the bottom of the cap **10** is a base member or pedestal **20** from which axially extends upwardly a bearing means in the form of a rod **22** provided with a peripheral groove **24** near its upper end.

The cap **10** is provided with side walls **26** adapted to be received on a split, annular insulating member **28**. For this purpose, the insulating member **28** is provided with a recessed section at its lower end indicated by the numeral **30**. For purposes of clarity in the description, only one of the insulating members **28** is shown in the drawings although it will be appreciated that two of the members **28** are required. It is to be further noted that the insulating member **28** subtends an angle of approximately 160°, such that when the pair of insulating members **28** are positioned in the cap **10** their opposing edges will be spaced apart from each other approximately 30°. The purpose of such spacing is to accommodate the interposition of the pole pieces shown in Figure 3, the latter being described further in the specification.

The insulating member **28** is provided with a plurality of spaced stationary contacts **32**, extending downwardly from its upper end a given distance and exposed on the inner radial surface of the insulating member. Bores are drilled through the insulating member **28** to enable axially aligned connection of lead **16** with the respective contacts **32**. Similarly, another pair of leads **16** pass upwardly through bores to connect with the pair of stationary contacts **34**.

The insulator **28** is further provided with arcuately shaped stationary contacts **36** and **38** spaced axially from the pairs of contacts **32** and **34**. The contact **36** includes an axial section exposed on the inner surface of the annular shaped insulator **28** and designated by the numeral **40**, and similarly contact **38** includes an axial section **42**. The axial sections **40** and **42** are dimensioned such that they subtend the total arc embraced by the pair of conductors **32** and pair of conductors **34**, respectively.

The contact 36 additionally includes a pie-shaped section 44 which extends at right angles to the axial section 40 radially inwardly. A similar construction is provided with the contact 42 in the form of a pie-shaped section 46. At the inner ends of the pie-shaped sections 44 and 46 are provided terminals 48 and 50, respectively, which are adapted to be connected with proper leads 14 passing through the bottom cap 10.

The bearing means or rod 22 of the cap 10 is dimensioned to rotatably receive an armature assembly designated by the bracketed numeral 52. The armature assembly 52 comprises generally an upper insulating disc 54, a lower insulating disc 56, and a laminated armature 58 for retention therebetween. In order that the armature assembly may be received on the bearing member 22, the upper disc 54 is provided with a central aperture 60 and similarly the armature and lower disc are provided, respectively, with a bore 62 and an aperture 64. It will further be seen that the upper disc is provided with a pair of apertures 66 adapted to be aligned with a pair of bores 70 in the armature 58, and a pair of apertures 68 in the lower disc 56. With such a construction, the pin 72 may be received through the apertures 66 and 68 on one side of the armature assembly to pass through one of the bores 70 for the purpose of holding the discs 54 and 56 in secure relationship with the armature 58. Towards this end, the pin 72 is designed to be riveted or otherwise fastened on the upper surface of the disc 54 and the lower surface of the disc 56. Similarly, a pin 74 is adapted to pass through the aperture 68, bore 70 and aperture 66 of the armature assembly on its other side and may be similarly riveted to secure the discs to the armature. It is to be noted, however, that the pin 74 is somewhat longer than the pin 72 and is provided at its upper end with a groove 76 at its periphery, the purpose of which will become clearer as the specification proceeds. The discs 54 and 56 are additionally provided with a pair of apertures 78 and 80, respectively, designed to form a means of retaining the moving contact means of the present invention. A lock washer 82 is shown disposed above the disc 54 and is adapted to be received in the groove 24 of the rod or bearing member 22 to retain the armature assembly 52 securely on the bearing member 22 in the assembled construction.

A pair of insulating blocks 84 are designed to be received in between the discs 54 and 56 in the space unoccupied by the armature 58. For this reason, the insulating block 84 is arcuately shaped as shown, only one of the insulating blocks being shown for clarity of illustration. The insulating block 84 is provided at its ends with axially extending slots 86 and 88. The slot 86 has a hooked inner end 90; similarly, the slot 88 has a hooked inner end 92. The slots 86 and 88 extend through the thickness of the insulating block and are designed to receive a set of spring-like moving contacts 94 and 96 extending radially from the upper portion of the block 84 and joined, respectively, to bridging members 98 and 100. The bridging members 98 and 100 similarly connect with another set of contacts 102 and 104, respectively, axially spaced below the other contacts.

Each set of contacts 94, 96, 102, and 104 is comprised of a plurality of reed-like members, for example, 94*a*, *b*, *c*, and *d*, each tuned to a different frequency. Each of the reeds is pre-loaded and completely dampened, and the individual reeds are designed so as to be capable of carrying the full load rating of the relay without harm for at least a short time. With such a construction, the possibility of contact not being established by the reeds is essentially eliminated.

The sets of contacts 94, 102 and 96, 104 are axially spaced with respect to the bearing member 22 so as to make proper contact with contacts 32 and 40, respectively, or contacts 34 and 42, respectively. Towards this end, it will be further appreciated that the reeds extend radially outwardly and that they are provided with a certain spring tension so that they will normally have a biasing force against the aligned contact members in the insulator 28.

In order to retain the insulating block 84 in secured relationship with the armature assembly, a bore 106 is provided through the insulating block which is designed to be aligned with the apertures 78 and 80 in the discs 54 and 56 so that the insulating block may be retained thereon with a pin 108 or a similar means of attachment.

For further assembly purposes, an upper cap 110 is provided which is designed to be received on the upper end of the insulating member 28. The upper cap 110 is provided with a downwardly extending inner boss 112 having a spring member 114 with one of its ends coupled thereto and its other end adapted to be coupled to the groove 76 in the pin 74 which projects above the upper surface of the disc 54 when the unit is assembled. This construction is more clearly shown in the view of Figure 2.

The cap 110 is provided with side walls 116 adapted to be aligned with and fit into a recess 118 on the upper edge of the insulating member 28, whereby the insulating member 28 and the armature assembly and insulating blocks disposed therein will be secured between the lower cap 10 and the upper cap 110.

It will be further noted that the cap 110 has opposed cutaway sections 120 adapted to accommodate pole pieces of electromagnetic means to be subsequently described. The cap 110 further includes a central aperture 122 for receiving the upper end of the bearing member or rod 22. It is further desirable to provide the cap 110 with a slot 124 of arcuate shape designed to limit movement of the armature from a first given position to a second given position. The slot 124 is aligned to receive the terminal end of the pin 74.

Referring now to Figure 2, the miniature switching apparatus or relay device is shown in its assembled condition. It will be noted that bores 126 extend throughout the length of the insulating member 28 in order to accommodate the proper leads 16. It will further be seen that insulation is shown as sealably surrounding the leads 16 and 18 in the apertures 12 and 14 in the bottom cap 10. This insulation may be in the form of plastic material hermetically injected therein and adapted to securely retain the leads in the bottom cap 10 as well as insulate them from the surrounding conductive areas.

In order to effect movement of the armature 58 and thereby actuate the relay, electromagnetic means energized from a separate source must be provided. The electromagnetic means may take different forms so long as pole pieces are included which are adapted for positioning to cause movement of the armature. In Figure 3, an electromagnetic assembly 128 is shown for illustrative purposes. The assembly includes a coil 130 provided with leads 132 for connection to a power source. The coil has an axially extending bore 134 dimensioned to accommodate a core 136 extending therethrough and connecting at its upper end with an angle member 138. The angle member 138 terminates in one pole piece 140. The other pole piece 142 connects through a member 144 with the bottom end of the core 136 at 146. With such a construction the pole pieces 140 and 142 are adapted to be received in the cutaway sections 120 of the top cap 116 (shown in Figure 1) to extend downwardly between the opposed edges of the insulating members 28 so as to be positioned radially between the armature 58 and the opposite insulating members 28.

In operation, the armature is biased by the spring 114 to a first position such that the end surfaces are just within the arc subtended by each of the insulating members 28 respectively. This first position of the armature 58 is shown schematically in Figure 4 by the solid lines. When power is applied to the leads 132 a maximum

torque is imposed on the armature which gradually decreases until the armature has its end surfaces aligned with the pole pieces positioned between the insulating members **28**, as indicated by the dotted lines. In contrast to conventional relay structures such an arrangement enables a maximum force to be imposed on the armature at the instant current is applied to the leads **132**, which thereafter decreases as the armature moves into alignment with the pole pieces **140** and **142** to finally stop when such alignment is achieved.

Normally, assuming a four-pole double throw operation, the moving contacts **94** and **102** would be in contact with one of the contacts **32** and the contact 40. Similarly, the moving contacts **96** and **104** would be in contact with one of the contacts **34** and the contact 42. Energization of the coil **130** would cause the armature to move and in consequence cause the moving contact **94** to move into contact with the other contact 32 and similarly the moving contact **96** to move into contact with the other contact **34**. During the entire operation, the contacts **102** would always be in contact with the contact **40** and similarly the contact **104** would be in contact with the contact **42**. Thus, as shown in the illustrative embodiment, each insulator member **28** would accommodate two poles.

It will be evident that the relay construction is such that regardless of acceleration forces or vibration, contact will always be maintained. In addition, the particular orientation of the unit with respect to gravitational forces or the like will have substantially no effect on the operation of the armature of the conducting members adapted to rotate therewith. It is further evident that this relay construction enables a balanced configuration insuring proper operation despite vibrational forces and enabling smaller overall dimensions and a consequent decrease in overall weight.

It will be appreciated, however, that various modifications and changes may be made particularly with respect to the electromagnetic means for actuating the armature. Such changes and modifications are deemed to be within the spirit and scope of the invention as defined by the following claims.

What is claimed is:

1. A relay comprising: an elongated bearing member extending in a given axial direction; an armature coaxial with and journaled for rotation on said bearing member from a first position to a second position; means fixed with respect to said bearing member for biasing said armature towards said first position; first insulating means fixed for rotation with said armature; second insulating means spaced radially outward of said first insulating means; first and second stationary contact means fixed in said second insulating means; moving contact means secured to said first insulating means and adapted to form an electrical connection with said first stationary contact means when said armature is in said first position and to form a connection with said second stationary contact means upon rotation of said armature to said second position; a coil having leads adapted for electrical energization; pole pieces magnetically connected to said coil, said pole pieces being positioned so as to actuate said armature from said first position to said second position upon energization of said coil.

2. A relay according to claim 1, in which said moving contact means comprise: a plurality of reed fingers spaced in parallel relationship one above the other; a bridging member connecting together the inner ends of said fingers, said bridging member being secured to said first insulating means, and the outer ends of said fingers being adapted to respectively contact said first stationary contact means when said armature is in said first position and to, respectively, contact said second stationary contact means when said armature is in said second position.

3. A relay according to claim 1, in which said second insulation means comprises one arcuate shaped insulating member subtending a given arc less than 180° and another arcuate shaped insulating member subtending said given arc, said one insulating member and said other insulating member being positioned in opposing co-axial end to end relationship with each other, whereby said pole pieces may be positioned in between, respectively, adjacent ends of said one insulating member and said other insulating member.

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